



CRITICAL ITEMS LIST (CIL)

No. 10-02-01-02R/02

SYSTEM:	Space Shuttle RSRM 10	CRITICALITY CATEGORY:	1
SUBSYSTEM:	Nozzle Subsystem 10-02	PART NAME:	Throat Inlet Assembly (1)
ASSEMBLY:	Nozzle and Aft Exit Cone 10-02-01	PART NO:	(See Section 6.0)
FMEA ITEM NO.:	10-02-01-02R Rev N	PHASE(S):	Boost (BT)
CIL REV NO.:	N (DCN-533)	QUANTITY:	(See Section 6.0)
DATE:	10 Apr 2002	EFFECTIVITY:	(See Table 101-6)
SUPERSEDES PAGE:	309-1ff.	HAZARD REF.:	BN-04
DATED:	27 Jul 2001		
CIL ANALYST:	B. A. Frandsen		
APPROVED BY:		DATE:	
RELIABILITY ENGINEERING:	<u>K. G. Sanofsky</u>		<u>10 Apr 2002</u>
ENGINEERING:	<u>B. H. Prescott</u>		<u>10 Apr 2002</u>

- 1.0 FAILURE CONDITION: Failure during operation (D)
- 2.0 FAILURE MODE: 2.0 Structural failure of the metal housing
- 3.0 FAILURE EFFECTS: Breakup and loss of nozzle causing loss of RSRM, SRB, crew, and vehicle
- 4.0 FAILURE CAUSES (FC):

FC NO.	DESCRIPTION	FAILURE CAUSE KEY
2.1	Nonconforming dimensions	
2.1.1	Initial manufacturing dimensions	A
2.1.2	Metal dimensions reduced by corrosion and/or refurbishment	B
2.2	Nonconforming material	
2.2.1	Improper heat treatment	C
2.2.2	Nonconforming voids, inclusions, or other material defects	D
2.3	Fatigue	E
2.4	Stress-corrosion cracking	F
2.5	Transportation, handling, and assembly damage	G

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5.0 REDUNDANCY SCREENS:

SCREEN A: N/A  
 SCREEN B: N/A  
 SCREEN C: N/A

6.0 ITEM DESCRIPTION:

1. Throat Inlet Housing is a part of the Nozzle Assembly, Final and is made of structural steel (Figure 1 and 2). Materials are listed in Table 1.

TABLE 1. MATERIALS

Drawing No.	Name	Material	Specification	Quantity
1U79147	Nose-Throat-Bearing Assembly			1/motor
1U79146	Nose-Throat Assembly, Nozzle			1/motor
1U79144	Throat-Inlet Assembly, Nozzle			1/motor
1U77640	Segment, Rocket Motor, Aft			1/motor
1U75547	Housing-Throat Support, Nozzle	D6AC Steel	STW4-2709	1/motor
1U78785	Forging, Throat Housing, Nozzle	D6AC Steel	STW4-2709	1/motor
	Corrosion-Preventive Compound and O-ring Lubricant	HD-2 Calcium Grease	STW5-2942	A/R
	Paint	Epoxy and a Polyamide Resin Activator	STW5-3225	A/R
	Primer	Pigmented Epoxy Resin Base and Polyamide Resin Activator	STW5-3226	A/R
	Sealant, Polysulfide	Synthetic Rubber, Polysulfide	STW5-9072	A/R

6.1 CHARACTERISTICS:

1. The throat inlet housing, also called the throat support housing, is a component of the nozzle assembly. It is a D6AC steel forging attached to the nose inlet housing on the forward end and the forward exit cone assembly on the aft end.

7.0 FAILURE HISTORY/RELATED EXPERIENCE:

1. Current data on test failures, flight failures, unexplained failures, and other failures during RSRM ground processing activity can be found in the PRACA Database.

8.0 OPERATIONAL USE: N/A

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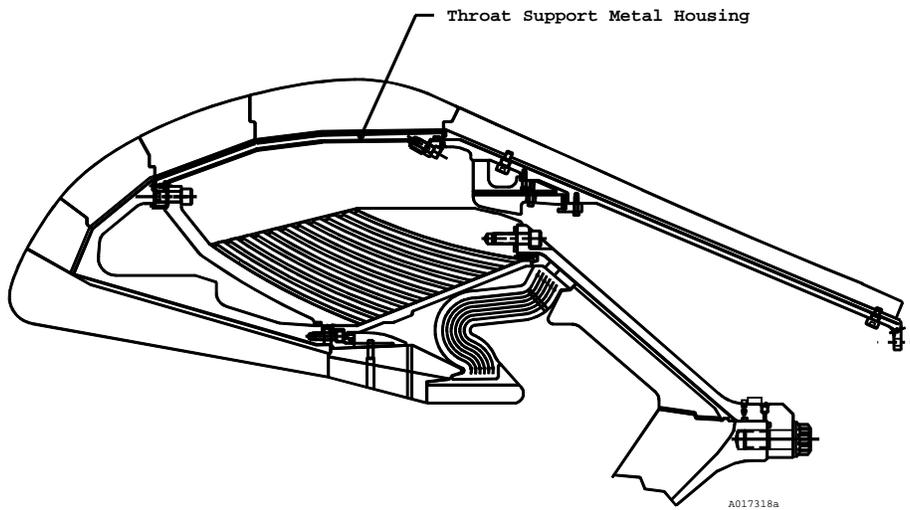


Figure 1. Nozzle Throat Support Metal Housing Location

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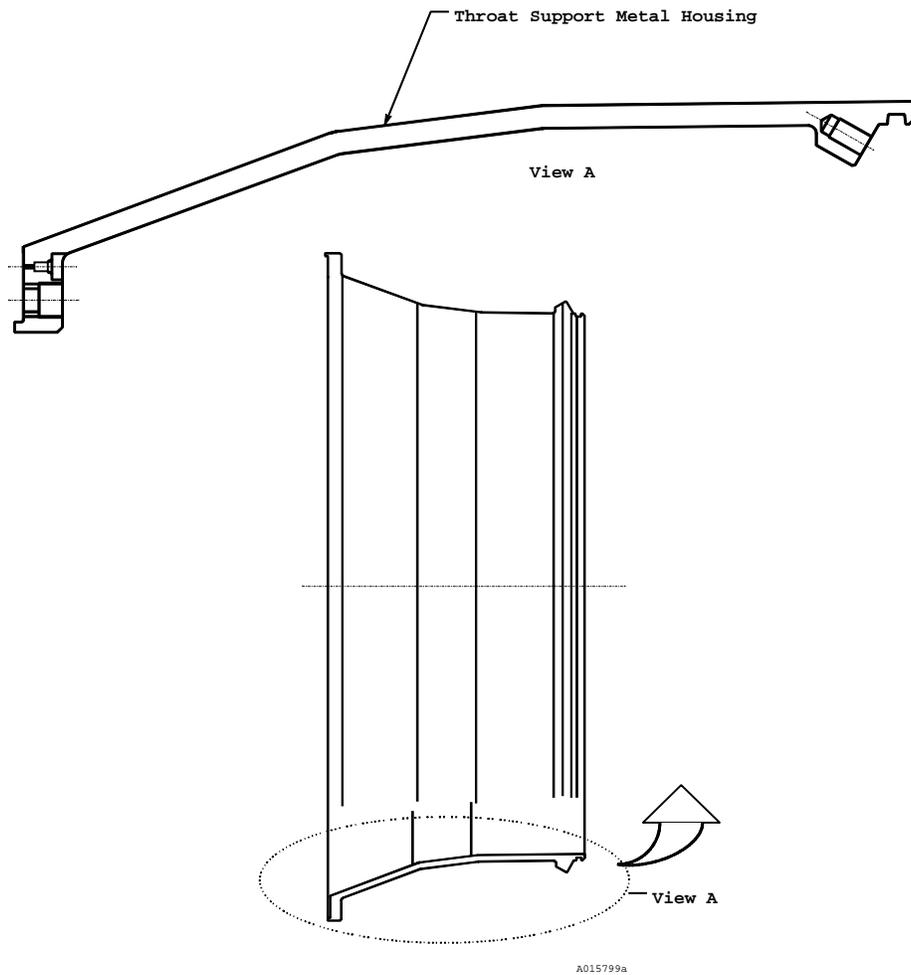


Figure 2. Nozzle Throat Support Metal Housing

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9.0 RATIONALE FOR RETENTION:

9.1 DESIGN:

DCN FAILURE CAUSES

- |                |     |   |
|----------------|-----|---|
| A              | 1.  | New throat support housing dimensions are per engineering drawings.   |
| B              | 2.  | Refurbished throat support housing dimensions are per engineering.  |
| A,B,C,D,E,F    | 3.  | Structural analyses per TWR-16975 verify that the throat support housing has a positive margin of safety based on factors of safety of 1.4 on ultimate and 1.1 on yield.  |
| A,B,F          | 4.  | The supplier provides corrosion protection for new housings per engineering drawings. Thiokol provides corrosion protection for refurbished housings per the refurbishment specification.   |
| B              | 5.  | Epoxy-polyamide primer and epoxy-polyamide coating are applied to the outer surface of the throat support housing per engineering drawings to prevent corrosion.  |
| A,B            | 6.  | Contamination control requirements and procedures are per TWR-16564.  |
| A,B            | 7.  | Assembly stresses are minimized as follows: <ul style="list-style-type: none"> <li>a. Mating surface flatness is controlled by inspection of machining operations</li> <li>b. Threads are cleaned and lubricated prior to assembly</li> <li>c. Assembly bolts are torqued in a prearranged sequence to preload values</li> </ul>  |
| C,D,E,F        | 8.  | The first production forging of the throat support housing is per JSC specifications and TWR-10717. The report concluded that the forging met all micro cleanliness and microstructure requirements of the D6AC steel specification, mechanical properties met or exceeded all requirements of the heat treatment specification, and the forging process produced a part free from re-entrant or sharply folded flow lines that could affect the integrity of the forged component. |
| D              | 9.  | Unacceptable cracks, voids, inclusions, and other material defects for new throat support housings are controlled per engineering.  |
| D              | 10. | Unacceptable cracks and other material surface defects for refurbished throat support housings are controlled per engineering.  |
| C,D            | 11. | Design verification analyses show that the materials and geometry of the throat support housing are acceptable for flight per TWR-18764-09  |
| C,E,F<br>C,E,F | 12. | The throat support housing is a heat treated D6AC steel forging with requirements for: <ul style="list-style-type: none"> <li>a. Ultimate strength</li> <li>b. Yield strength</li> </ul>  |
| E              | 13. | Material type and composition of steel is carefully controlled by the supplier. The heat treatment includes frequent logging of critical points and conditions.   |
| E,F            | 14. | The basic forging was analyzed per JSC specification SE-R-0006 and reported in TWR-10717. This report shows that the principal grain flow is oriented parallel with the principal stresses expected.  |
| E              | 15. | Development and qualification motors were fired to demonstrate compliance with nozzle design parameters.  |

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|-----------|--|
| F         | 16. The throat support housing has low-to-moderate resistance-to-stress corrosion per MSFC specifications and, therefore, requires a Material Use Agreement.   |
| E,F       | 17. The throat support housing is a fracture control item per TWR-16875. TWR-16875 documents that after passing surface inspection, any undetectable flaw will not propagate to a critical size in four additional missions before the next inspection.  |
| G         | 18. Analysis is conducted by Thiokol engineering to assess vibration and shock load response of the RSRM nozzle during transportation and handling to assembly and launch sites per TWR-16975.   |
| G         | 19. Handling and lifting requirements established for the RSRM components are similar to those for previous and current programs conducted by Thiokol per TWR-13880.   |
| G         | 20. Transportation and handling of nozzle throat assembly items by Thiokol is per IHM 29.  |
| G         | 21. The throat assembly is covered with a protective cover and stored in a temperature controlled building until used as a part of a larger assembly.  |
| G         | 22. The RSRM and its component parts, when protected per TWR-10299 and TWR-11325, are capable of being handled and transported by rail or other suitable means to and from fabrication, test, operational launch, recovery or retrieval, and refurbishment sites.  |
| G         | 23. Positive cradling or support devices and tie downs that conform to shape, size, weight, and contour of components to be transported are provided to support RSRM segments and other components. Shock mounting and other protective devices are used on trucks and dollies to move sensitive loads per TWR-13880.  |
| G         | 24. Support equipment used to test, handle, transport, and assemble or disassemble the RSRM is certified and verified per TWR-15723.   |
| G         | 25. The nozzle assembly is shipped in the aft segment. Railcar transportation shock and vibration levels are monitored per engineering and applicable loads are derived by analysis. Monitoring records are evaluated by Thiokol to verify shock and vibration levels per MSFC Specification SE-019-049-2H were not exceeded. TWR-16975 documents compliance of the Nozzle with environments per MSFC specifications.  |
| G         | 26. A protective plug is installed per shop planning in the leak check port of the throat support housing to protect the port from damage during handling and installation.  |
| E,F,G     | 27. Analysis of carbon-cloth phenolic ply angle changes for the nozzle was performed. Results show that redesigned nozzle phenolic components have a reduced in-plane fiber strain and wedge-out potential per TWR-16975. New loads that were driven by the Performance Enhancement (PE) Program were addressed in TWR-73984. No significant effects on the performance of the RSRM nozzle were identified due to PE.  |
| 533 E,F,G | 28. Thermal analysis per TWR-17219 shows the nozzle phenolic meets the new performance factor equation based on the remaining virgin material after boost phase is complete. This performance factor will be equal to or greater than a safety factor of 1.4 for the throat assembly per TWR-74238 and TWR-75135. (Carbon phenolic-to-glass interface, bondline temperature and metal housing temperatures were all taken into consideration). The new performance factor will insure that the CEI requirements will be met which requires that the bond between carbon and glass will not exceed 600 degree F, bondline of glass-to-metal remains at ambient temperature during boost phase, and the metal will not be heat affected at splashdown. |

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9.2 TEST AND INSPECTION:

FAILURE CAUSES and  
DCN TESTS (T)

CIL CODE

1. For New Housing, Throat Support, Nozzle verify:
 

A,B	a.	Corrosion protection is per specification	AFN007
A	b.	Flatness	AFN030,AFN031
A	c.	Diameter	AFN044,AFN048
A	d.	Profile	AFN130,AFN161
A	e.	Minimum full thread	AFN165
A	f.	Minor diameter max depth	AFN172
A	g.	True position	AFN176,AFN176A,AFN176B
A	h.	Thickness	AFN200,AFN201
C,D,E,F (T)	i.	Carburization	AFN019
C,D,E,F (T)	j.	Decarburization	AFN033
D,E,F (T)	k.	Magnetic particle	AFN107
C,D,E,F (T)	l.	Ultimate strength	AFN121
C,D,E,F (T)	m.	Reduction in area	AFN121C
C,D,E,F (T)	n.	Yield strength	AFN162A
C,D,E,F (T)	o.	Elongation	AFN162B
  
2. For Refurbished Housing, Throat Support, Nozzle verify:
 

B	a.	Roundness	AFN135,AFN132
B	b.	Height	AFN058
B	c.	Straightness	AFN126
B	d.	Damaged threads	AFN170
B	e.	Bolt hole deformation	AFN014
B	f.	Surface defects	AFN010
B	g.	Deformed parts	AFN062
B	h.	Thickness	AFN199
C,D,E	i.	Heat damage	AFN077
D,E,F (T)	j.	Magnetic particle	AFN096
  
3. For New Throat Inlet Assembly, Nozzle verify:
 

B	a.	Absence of corrosion on the throat support housing	AAW001,AAW003
B	b.	Bonding surfaces are free of unacceptable surface contamination (black light)	AAW036
B	c.	Cleanliness of the Throat Support Housing	AAW037
B	d.	Primer applied to outside diameter surface of throat support housing	AAW071
B	e.	Top coating applied to outside diameter surface of throat support housing	AAW113
  
4. For New Nose-Throat-Bearing Assembly, Nozzle verify:
 

B	a.	Absence of corrosion	ADO000
B	b.	Application of filtered grease	ADO001
B	c.	Application of the sealant	ADO014
B	d.	Free of contamination	ADO015
  
5. For New Nose-Throat Assembly, Nozzle verify:
 

B	a.	Application of filtered grease to Housing-Throat Support, Nozzle forward end sealing surfaces	ADN013
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|---------|-----|---|---------------|
| B       | b.  | Housing-Throat Support, Nozzle forward end sealing surface is free from corrosion and contamination prior to assembly | ADN123        |
|         | 6.  | For New Nozzle Assembly, Final verify:  |               |
| A       | a.  | Plastic-to-plastic interfaces are filled with sealing compound after assembly and blended to adjacent contour         | ADR029        |
| B       | b.  | Throat support housing is cleaned prior to assembly   | ADR051        |
| B       | c.  | Application of filtered grease to Housing-Throat Support, Nozzle aft end sealing surface prior to assembly            | ADR103        |
| B       | d.  | Housing-Throat Support, Nozzle aft end mating surface is free from corrosion and contamination prior to assembly      | ADR261        |
|         | 7.  | For New Forging, Throat Housing, Nozzle QA verify:  |               |
| C,D,E,F | (T) | a. Chemical composition   | AFN024        |
| C,D,E,F | (T) | b. Grain size   | AFN065        |
| D,E,F   | (T) | c. Inclusion rating   | AFN090        |
| C,D,E,F | (T) | d. Macro structure  | AFN091        |
| D,E     | (T) | e. Ultrasonic   | AFN177,AFN184 |